

Chapter 5

Azure Solutions

MICROSOFT EXAM OBJECTIVES COVERED IN THIS CHAPTER:

DESCRIBE CORE SOLUTIONS AND MANAGEMENT TOOLS ON AZURE

✓ Describe core solutions available in Azure

- Describe the benefits and usage of Internet of Things (IoT) Hub, IoT Central, and Azure Sphere
- Describe the benefits and usage of Azure Synapse Analytics, HDInsight, and Azure Databricks
- Describe the benefits and usage of Azure Machine Learning, Cognitive Services, and Azure Bot Service
- Describe the benefits and usage of serverless computing solutions that include Azure Functions and Logic Apps
- Describe the benefits and usage of Azure DevOps, GitHub, GitHub Actions, and Azure DevTest Labs





Chapter 2, “Azure Core Services,” introduced primary services available in Azure, including core data services such as Azure SQL Database and Cosmos DB. Subsequent chapters explored Azure networking and security-related services. This chapter continues your exploration with a look at Azure solutions in the areas of Internet of Things (IoT), artificial intelligence (AI), and serverless computing.

Internet of Things (IoT)

Loosely defined, the Internet of Things (IoT) describes connected devices equipped with sensors that collect data and send that data to an endpoint for logging, processing, and/or other actions. Consider a manufacturing floor where sensors track the manufacturing process and send data back to a centralized system that operators and engineers use to monitor and control the manufacturing process. Or, imagine a connected house where the refrigerator, oven, microwave, lighting systems, garage door, thermostat, and security system all collect and send data to a central app or service to enable the homeowner to monitor and potentially control the function of all of these systems. Finally, consider an automobile manufacturer that builds sensors into its vehicles to monitor performance and sends that data to Azure for real-time analytics. These scenarios are examples of IoT.

Consolidating sensor data is just one aspect of IoT. Controlling and managing the distributed devices is another aspect. For example, you might need to update firmware in devices that you manage in addition to collecting data from them.

Azure includes several services that enable organizations to integrate IoT devices **quickly and easily** and deploy solutions based on IoT. The following sections explore these services.

Azure IoT Hub

Azure IoT Hub is an Azure-hosted service that functions as a message hub for **bidirectional communication** between your deployed IoT devices and Azure services. IoT Hub supports multiple protocols and open source software development kits (SDKs), enabling it to integrate most IoT devices. IoT Hub is **highly scalable**, which means it can integrate billions of devices.

IoT Hub supports multiple communication and control functions, including the following:

- Device-to-cloud **telemetry to collect data**
- Device-to-cloud **file upload** to collect and transfer data

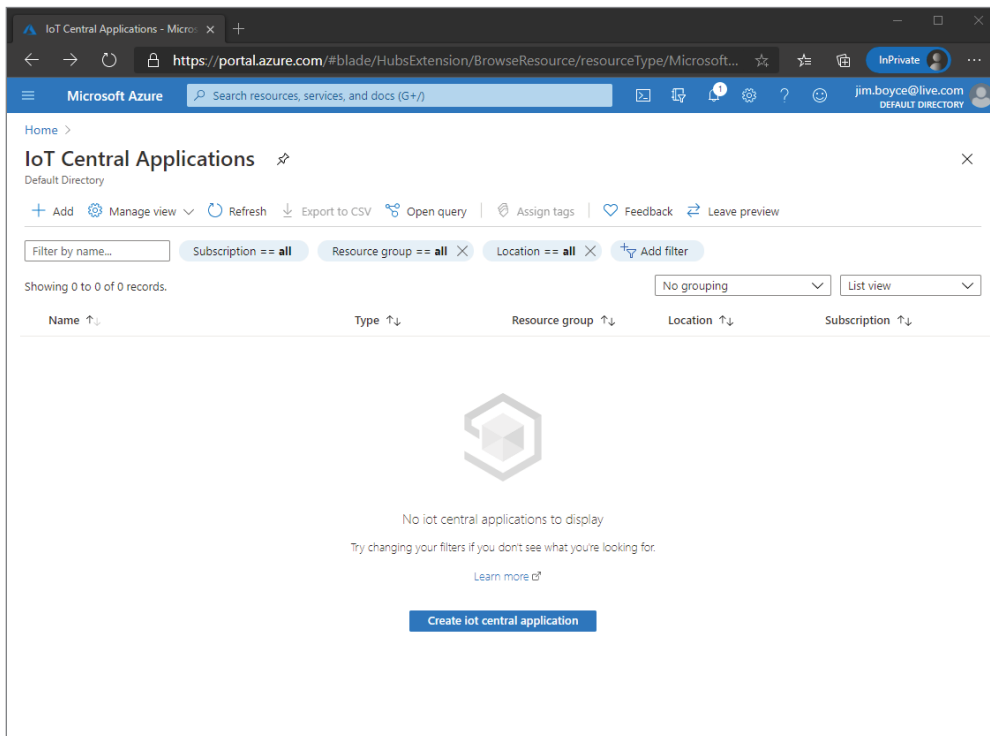
- **Request/reply** methods for controlling devices from the cloud
- **Monitoring**

Communication with IoT Hub is not limited to devices and IoT Hub. IoT Hub can route messages received from devices to other Azure services as needed. In summary, IoT Hub is the **service that integrates** your IoT devices and other Azure services. However, IoT Hub does not provide analysis services or dashboards for viewing device state or analyzing data. That is where IoT Central comes in.

Azure IoT Central

Azure IoT Central (Figure 5.1) builds on the functions provided by IoT Hub to provide **visualization, control, and management features** for IoT devices. Through IoT Central's interface, you can easily connect new devices, view telemetry, view overall device performance, create and manage alerts that notify you when a device needs maintenance, and push updates to devices when needed.

FIGURE 5.1 IoT Central provides a visual interface for viewing and managing IoT devices and telemetry.



You can imagine that managing 1,000 discrete devices would be challenging, and millions of devices would be almost impossible to manage without a simplified means of deployment. IoT Central provides that simplification through *device templates*, which allow you to connect to new devices without any coding in IoT Central. IoT Central creates the dashboards, alerts, and other visualization and management elements based on the template. The device just needs to be compatible with the device template specifications. So, if you deploy 1,000 Model RG12 Gold Widgets, you use the corresponding template—which already “knows” how to connect to that device type—to connect to and begin managing those 1,000 devices, all without writing a single line of code.

Azure Sphere

Azure Sphere is an integrated IoT solution that consists of three key parts:

- **Azure Sphere micro-controller units (MCUs):** The MCU is a **hardware component** built into the IoT device that processes the OS and signals from attached sensors.
- **Management software:** A custom Linux operating system that **manages communication** with the security service and runs the vendor’s device software.
- **Azure Sphere Security Service (AS3):** This Azure service handles certificate-based device **authentication** to Azure, ensures that the device has not been compromised, and pushes OS and other software updates to the device as needed.

Although you can build a complete IoT solution using just IoT Hub and IoT Central, Azure Sphere gives you the ability to create a custom, highly secure IoT solution.

Artificial Intelligence

Wikipedia defines artificial intelligence (AI) as “any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.” Generally speaking, AI systems **simulate human intelligence** to process vast amounts of data to learn and problem solve.

AI falls into two broad categories: *deep learning* and *machine learning*. Deep learning uses a system modeled on the human mind to enable the service to discover information, learn, and grow. Machine learning is a data science technique that uses data to train a data model, test the model for relative accuracy, and then apply the model to new data. A properly trained model should then be able to accurately forecast behaviors, events, and outcomes based on its analysis of past data elements.

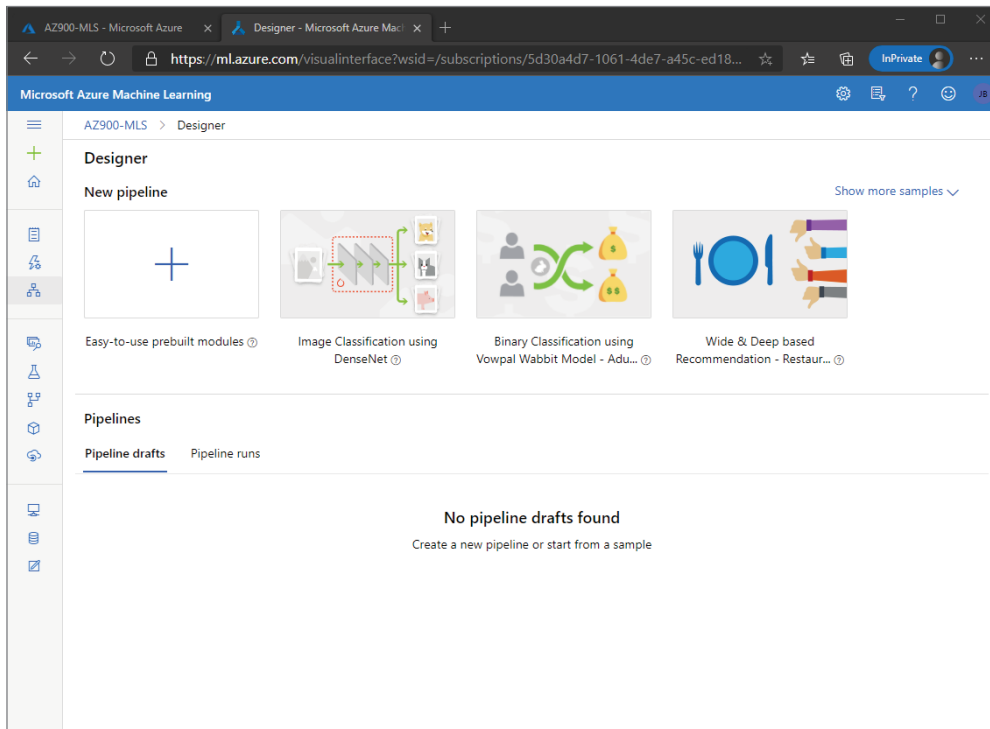
Azure offers three services to enable you to take advantage of AI, each explored in the following sections.

Azure Machine Learning

Azure Machine Learning consists of a collection of Azure services and tools that enable you to use data to train and validate models. Through testing, you determine the model that provides the most accurate predictions. Then you can deploy the model for use through a web API endpoint. Azure Machine Learning provides a number of features that enable you to define how to obtain and manage data, train and validate predictive models, manage the process and resources for scoring your algorithms, and deploy the final model to an API endpoint, where it can be used in real time by other applications.

Azure Machine Learning encompasses multiple services and features to support your AI development efforts. For example, Azure Machine Learning Studio (Figure 5.2) is a web portal through which developers can create no-code and code-first solutions using a selection of tools, including drag-and-drop model design. You can also use Machine Learning Studio to manage assets and resources, publish your models as web services, and more.

FIGURE 5.2 Azure Machine Learning Studio provides a rich portal-based experience for creating, managing, and publishing machine learning models.





The legacy ML Studio (classic) tool for creating and managing machine learning models is still available but lacks many of the features included in Machine Learning Studio. ML Studio does not interoperate with Azure Machine Learning.

Azure Cognitive Services

Azure Cognitive Services provides machine learning models designed to **interact with humans** and execute cognitive functions that humans would normally do, such as **recognizing images**. The following list summarizes the services available within Azure Cognitive Services:

- **Language:** Use Azure Cognitive Services to process natural language to determine, for example, the user's sentiment or what the user is requesting or asking.
- **Speech:** Use Cognitive Services to convert speech into text or text into speech. Speech services can also translate from one language to another, as well as recognize and verify a speaker.
- **Vision:** This service provides identification and recognition services for analyzing images, videos, and similar visual data.
- **Decision:** Use this service to personalize a user experience with recommendations, monitor and remove offensive content, and evaluate time-series data for abnormalities.

Azure Cognitive Services includes a broad range of prebuilt machine learning models that you can use with **very little coding**. You can also create custom models when needed.

Azure Bot Service

Azure Bot Service enables you to create and use virtual agents to **interact with users** by **answering questions**, **gathering information**, and potentially **initiating activities** through other Azure services. Azure Bot Service can use other services such as Cognitive Services to understand what users are asking and respond accordingly.

Serverless Computing

Chapter 1, “Cloud Concepts,” touched on serverless computing and its benefits. To recap, serverless computing enables you to run code without deploying and managing a server to host and run that code. Although ultimately there is a server running your code, that server is **abstracted**, meaning you have no visibility to or ability to directly interact with the server. Instead, you focus solely on the code and its function. In addition to simplifying management of the solution, Azure handles **scaling** when needed. In addition, you **pay only** for the resources used by the code.

Azure offers two primary serverless computing services, Azure Functions and Azure Logic Apps, which are explored in the following sections.

Azure Functions

The Azure Functions service enables you to host a **single method** or function that runs in response to an event such as a queued message, HTTP request, or timer event. You can use any of several programming languages, such as Python, Java, JavaScript, C#, and PowerShell, to create functions. Like many other services, the Azure Functions service **scales automatically**, enabling your function to scale to meet changes in demand without any interaction or configuration by your developers. Perhaps best of all, you pay only for the **time and resources needed** while a function is running.

Generally, an Azure function is *stateless*, meaning it does not store its state from execution to execution. Instead, it executes the same every time it responds to an event. You can configure a function to maintain state by connecting an Azure storage account to the function, enabling it to store its state between executions. You can also use an extension called **Durable Functions** to chain together functions and maintain their state while the functions are executing.

Azure Functions is an excellent solution for building small blocks of code that run for a very short period in response to a triggering event, as described earlier.

Azure Logic Apps

Functions are great for very discrete processing tasks, but when you need something much more complex, like a workflow or a process, Azure Logic Apps is a good solution. Logic Apps enables you to create **no-code** and **low-code** solutions hosted in Azure to automate and orchestrate tasks, business processes, and workflows. Like Functions, Logic Apps are serverless in that you **focus on the app** rather than the underlying server or resources needed to maintain and run the app.

You build Logic Apps using a **web-based design** environment. Like many workflow solutions, Logic Apps lets you build the app by connecting *triggers* to *actions* with various *connections*. For example, a message arriving in a queue is a trigger. The event you associate with that trigger might be passing the message to another Azure service through that service's connection. Whatever the situation, simply understand that Logic Apps gives you the ability to **graphically** create low-code and no-code **complex workflows** using a web-based design environment.



Azure Functions and Azure Logic Apps can integrate, allowing you to call one from the other. For example, you might create a function that passes data to a logic app for processing. Or you might call a function from a logic app.

Functions and Logic Apps are both priced based on consumption, like most Azure services. However, the Azure Functions service is priced based on the number of function executions and running time for each. The Azure Logic Apps feature is priced based on the number of executions and the type of connectors that the app uses.

DevOps

Software development can be a complex and time-consuming process that uses IT services but is not always well integrated into IT. The term *DevOps* describes process, practices, and services designed to integrate development and IT with the end goal of simplifying and streamlining development efforts while maintaining high quality. For example, assume your development team needs to develop and deploy a new application that will require 20 virtual machines of various types. DevOps services help simplify and automate that deployment process.

Azure includes a handful of services targeted at DevOps. The following sections describe these services.

Azure DevOps Services

Azure DevOps is not a single service but rather a group of services designed to enable and support development at multiple stages in the development process. The services include the following:

- **Azure Artifacts:** Provides a repository for storing development artifacts such as compiled source code. Artifacts can be used by other services for testing or deployment.
- **Azure Boards:** Provides capabilities for managing development projects and individual items, including user stories, backlog items, tasks, features, and bugs.
- **Azure Pipelines:** Enables you to automatically build and test code projects.
- **Azure Repos:** A source-code repository for publishing and collaborating on development projects.
- **Azure Test Plans:** Provides an automated testing tool for testing code.

GitHub and GitHub Actions

GitHub is a popular code repository for open source software that enables code sharing, development collaboration, review and discussion, documentation, and other collaboration mechanisms for sharing and collaborating on open source code projects. GitHub Actions provides workflow automation services.

GitHub and GitHub Actions offer many of the same functions as Azure DevOps, and these services can integrate. In general, GitHub is the appropriate choice for collaborating on open source projects and DevOps is the appropriate choice for enterprise/internal projects.

Azure DevTest Labs

Azure DevTest Labs automates the deployment, configuration, and decommissioning of virtual machines and other Azure resources. For example, let's assume you need to deploy 20 virtual machines of various types in a test subnet with specific network security groups and other resources. You can use DevTest Labs to automate that deployment, and when testing is complete, you can decommission all of those services so that you pay only for the resources you need for testing while you are actually testing them. All of this can be largely automated, greatly simplifying the development testing process.

DevTest Labs can use Azure Resource Manager (ARM) templates to deploy nearly any type of Azure resource, enabling your development team to model application environments and quickly provision and decommission not only the servers but support resources as well. However, DevTest Labs does not provide monitoring, alerting, or telemetry services to monitor those resources.

Summary

This chapter covered the core solutions in Azure that support IoT development and implementation, including IoT Hub, IoT Central, and Sphere. These services allow you to deploy IoT solutions incorporating standard and custom IoT devices, manage those devices, and gather and report on data sent from the devices.

The chapter also covered AI services, including Azure Machine Learning, Azure Cognitive Services, and Azure Bot Service. These services enable you to build complex and powerful solutions for analyzing data and interacting with users in an automated way.

Finally, this chapter explored many of the development-related services and solutions in Azure that allow you to more easily and effectively deploy custom solutions with minimal expense. Azure Functions and Azure Logic Apps let you build simple functions and more complex workflow processes without worrying about the underlying servers and services. Azure DevOps provides a broad range of services and solutions for developing, managing, collaborating on, and deploying code.

Exam Essentials

Internet of Things The IoT-related services in Azure enable you to build complex IoT solutions. Azure IoT Hub functions as a hub for bidirectional communication between IoT devices and Azure services. IoT Central builds on IoT Hub to provide visualization, control, and management features for IoT devices. Azure Sphere enables you to deploy and manage IoT solutions through custom devices using a combination of integrated microcontroller units, management software, and certificate-based security services, ensuring a secure IoT solution tailored to your organization's needs.

Machine Learning and AI Azure Machine Learning consists of a collection of Azure services and tools that you use to train and validate AI models. Azure Cognitive Services provides a comprehensive set of machine learning models to execute cognitive functions that humans would normally do, such as recognizing images, performing speech-to-text and text-to-speech functions, and translating languages. Azure Bot Service enables you to create and use virtual agents to interact with users, answering questions, gathering information, and initiating corresponding activities.

Development and Serverless Computing With Azure Functions, you can create simple, typically stateless bits of code that execute in response to events. With the addition of a storage account, you can make functions stateful, maintaining their state between executions. Azure Logic Apps, also a serverless computing solution, enables you to build low-code and no-code workflow and process solutions using a web-based design interface.

DevOps features in Azure are designed to simplify code development and collaboration. Azure DevOps Services consists of several services for code management, testing, and deployment. GitHub and GitHub Actions provide many of the same types of features but are targeted at open source projects. Finally, Azure DevTest Labs provides the means for development teams to easily deploy virtual machines and other Azure services for code testing, then quickly and easily decommission those resources when testing is completed.

Review Questions

1. Is the underlined portion of the following statement true, or does it need to be replaced with one of the other fragments that appear below?

IoT Hub is an Azure service that enables you to view telemetry from IoT devices and view a dashboard showing device state.

- A. supports secure communication between devices and controls applications using custom microcontrollers and certificate-based authentication of devices.
 - B. provides bidirectional communication between IoT devices and other Azure services and/or an IoT application.
 - C. enables you to easily manage deployed IoT devices with dashboards and reports.
 - D. No change is needed.
2. Your organization is building an IoT solution that enables you to monitor and control thousands of sensors deployed in your manufacturing facilities. You need to be able to **analyze the telemetry data** coming from the devices. Which of the following is the appropriate Azure solution?
- A. IoT Hub
 - B. IoT Central
 - C. Sphere
 - D. None of the above

3. Is the underlined portion of the following statement true, or does it need to be replaced with one of the other fragments that appear below?

Azure Machine Learning consists of multiple services that enable you to use data to train and validate AI models.

- A. enables you to create virtual machine agents that learn from user interaction and provide corresponding services such as answering questions.
 - B. can be used to analyze photos and videos for content.
 - C. enables you to deploy AI models as stand-alone applications in Azure or on premises.
 - D. No change is needed.
4. Which of the following describe Azure Machine Learning Studio? (Choose all that apply.)
- A. It provides the ability for developers to create no-code and code-first machine learning solutions.
 - B. It provides a web portal through which developers can use drag-and-drop to create machine learning solutions.
 - C. It enables you to deploy machine learning models as web services.
 - D. None of the above

5. Which of the following are capabilities of Azure Cognitive Services? (Choose all that apply.)
- A. Processes natural language to determine what a user is asking.
 - B. Performs translation from one language to another.
 - C. Acts as a virtual agent to interact with users in a humanlike way.
 - D. Analyzes photos to identify content within them.

6. Is the underlined portion of the following statement true, or does it need to be replaced with one of the other fragments that appear below?

Azure Bot Services provides the capability to analyze photos and other data types to identify specific content.

- A. is a stand-alone Azure service that cannot interact with other Azure services.
 - B. provides natural language translation services.
 - C. enables you to build virtual agents that interact with users in a humanlike way.
 - D. No change is needed.
7. Which of the following Azure services provides the ability to create workflow-based processes?
- A. Functions
 - B. Bot Service
 - C. Logic Apps
 - D. None of the above
8. Which of the following correctly describe Azure Functions? (Choose all that apply.)
- A. Functions are typically stateless but can be made stateful with the addition of a storage account.
 - B. Functions operate independently and cannot be integrated with Logic Apps.
 - C. You can use drag-and-drop features to create functions that automate processes.
 - D. Functions can be developed with any of several programming languages.
9. Is the underlined portion of the following statement true, or does it need to be replaced with one of the other fragments that appear below?
- Azure Artifacts is a component service of Azure DevOps that provides a repository for storing development artifacts such as compiled source code.
- A. provides a means for managing development projects and individual items such as features and bugs.
 - B. is intended for open source code development projects.
 - C. works in conjunction with Azure Blueprints to provide a means of storing information about Azure resources.
 - D. No change is needed.

10. Which of the following is intended primarily for collaborating on open source development efforts?
- A. Azure Repos
 - B. Azure Boards
 - C. GitHub
 - D. Azure DevTest Labs
11. Is the underlined portion of the following statement true, or does it need to be replaced with one of the other fragments that appear below?
- Azure DevTest Labs provides a customizable development environment in which your developers can collaborate on code projects.
- A. provides alerting and monitoring tools to analyze telemetry from servers in an application test.
 - B. enables your development team to quickly and easily deploy virtual machines and other Azure resources to test an application, then decommission those resources.
 - C. can provision Windows servers but not Linux servers.
 - D. No change is needed.

